



ASSESSMENT OF HEAVY METAL ACCUMULATION IN SOME FRUITS AND VEGETABLES IN SELECTED MARKETS IN ABUJA, NIGERIA

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Abstract

The accumulation of heavy metals in food crops poses a significant threat to food safety and public health, especially in developing countries. This study assessed the concentration of selected heavy metals—cadmium (Cd), cobalt (Co), lead (Pb), chromium (Cr), and arsenic (As)—in ten commonly consumed fruits and vegetables obtained from two major markets (Gwagwalada and Zuba) in Abuja, Nigeria. Samples were digested using nitric acid and analysed with Atomic Absorption Spectrophotometry. Results revealed elevated levels of heavy metals in most samples, with concentrations of Cd (1.72–3.00 mg/kg), Pb (0.00–25.93 mg/kg), Co (1.10–5.80 mg/kg), and As (0.00–10.50 mg/kg) significantly exceeding the permissible limits set by the World Health Organization (WHO) and Food and Agriculture Organization (FAO). Chromium was detected only in a few samples at near-permissible levels. A comparative analysis with similar studies across Nigeria suggests a nationwide concern about heavy metal contamination in fruits and vegetables due to environmental pollution, inadequate waste management, and unsafe agricultural practices. These findings underscore the urgent need for regular monitoring, regulatory enforcement, and public education on food safety.

Keywords: Heavy metals, fruits, vegetables, cadmium, lead, public health, Abuja, Nigeria, food contamination, atomic absorption spectrophotometry

Introduction

Fruits and vegetables are essential components of the human diet, providing vital nutrients, antioxidants, and dietary fibre. However, their safety is increasingly being compromised by environmental pollution, particularly from heavy metals, which pose significant risks to human health. Heavy metals such as cadmium (Cd), lead (Pb), arsenic (As), chromium (Cr), and cobalt (Co) are known to accumulate in plants through contaminated soil, water, and atmospheric deposition, often resulting from agricultural practices, industrial discharges, and urban runoff.

Heavy metals are defined as metallic elements with a greater density than water. They are naturally occurring elements with a large atomic weight and at least five times the density of water. Metalloids such as Arsenic(As), which can cause toxicity at low exposure are also considered as heavy metals (Fergusson, 1990, Tchounwou *et al.*, 2012). Many studies have reported that heavy metals accumulated by vegetables can be taken up by humans via the food chain, making

vegetables the primary source of the heavy metals in human (Ngwene *et al.*, 2020, Ahmed *et al.*, 2022)

Heavy metals are unique among pollutants that cause adverse effects in that they occur naturally and are somewhat ubiquitous in the environment. Various heavy metals such as chromium (Cr), cadmium(Cd), nickel(Ni), copper (Cu), Zinc (Zn), lead (Pb), mercury(Hg), and arsenic (As) are recognized as biologically dispensable and detrimental to the aquatic ecosystem.

Regardless of how these metals are used, in consumer products or industrial processes some level of human exposure is inevitable. Many of them are biologically essential but become toxic with increasing dosage and are becoming an emerging class of human carcinogens as several metals and their compounds are suspected to have carcinogenic potential in humans (ARC, 1990).

Heavy metal contamination is a serious environmental and health concern in Nigeria with significant impacts from mining, E-waste and food sources posing risks to human health and the ecosystem. Exposure to heavy metals

particularly lead and mercury, can cause a range of health problems including, neurological damage, developmental issues and even death. Heavy metals can accumulate in food crops posing a risk to human health through consumption.

Various sources of heavy metals have been reported in Nigeria including anthropogenic sources of environmental contamination from agricultural activities involving pesticide and herbicide application, use of contaminated irrigation water, municipal waste used for fertilization as well as mineral fertilizer containing traces of heavy metals(Alloway *et.al*, 1999); Gray *et al*, (1999).

It has been established that the uptake of heavy metals in vegetables is influenced by climate, air deposition and the concentration of heavy metals in soil, (the nature of the soil used to produce the vegetables and the maturity of the plants during harvesting. Scott *et.al*, 1996) Hosen *et. al*, 2024). Such accumulated heavy metals ultimately end up in the soil and water from where they might be absorbed by various parts of the plants and can subsequently enter the human food chain if the plants are consumed(Laura, 2017).

In Nigeria, particularly within the Federal Capital Territory (FCT), the rapid pace of urbanization and agricultural intensification may increase the potential for environmental contamination. Local markets serve as the primary points for food distribution and consumption, making it imperative to assess the safety of food items sold in these areas.

This study aimed to determine the concentration levels of selected heavy metals in commonly consumed fruits and vegetables obtained from two area councils—Gwagwalada and Bwari (Zuba market)—within Abuja. The findings are evaluated against World Health Organization (WHO) and Food and Agriculture Organization (FAO) permissible limits to determine potential public health risks.

Materials and Methods

Table 1: Average Concentration of Heavy Metals in Fruits and Vegetables in Gwagwalada

Fruits and Vegetable	Cd(mg/kg)	Co (mg/kg)	Pb(mg/kg)	Cr(mg/kg)	As (mg/kg)
Beetroot	2.03	4.14	0	0	2.6
Watermelon	2.32	5.8	5.22	0	0
Cucumber	2.18	2.41	7.5	0	0.96
Pawpaw	1.72	5.01	0	0	0.96
Banana	2	3.13	14.62	0	10.5
Tomato	1.85	4.5	12.88	0	4.67
Carrot	1.94	4.33	2.68	0	0
Cabbage	2.36	1.6	16.73	0	0.94
Ugwu	2.53	4.38	21.41	0	4.03
Spinach	2.58	1.1	9	0	8.1
FAO/WHO	0.1	0.05	0.3	2.3	0.3

A total of 10 different types of fruits and vegetables (watermelon, pawpaw, banana, cucumber, carrots, cabbage, tomatoes, beetroot, African spinach [green, *Amaranthus hybridus*], and uguwu (fluted pumpkin, *Telfairia occidentalis*)) were purchased from markets in two of the Area Councils of Abuja—Gwagwalada and Bwari—between February and June 2025.

Sample Preparation and Treatment

The selected fruit and vegetable samples were processed at the Sheda Science and Technology Complex, Kwali area Council, FCT, Abuja, Nigeria.

Digestion of the weighed sample was performed in a 250 cm³ glass conical flask covered with a watch glass. Three grams of each well-mixed sample were digested in 20 cm³ of nitric acid (HNO₃) on a hotplate for 3 hours at 110°C. After evaporation to near dryness, the sample was diluted with 20 cm³ of 2% nitric acid and transferred into a 100 cm³ volumetric flask after being filtered through Whatman No. 42 filter paper. The solution was then made up to volume with deionized water (Ming and Lena, 2001). The filtrates were analysed using a Thermo Scientific Atomic Absorption Spectrophotometer (iCE 3000 AA2134104v1.30).

Data Analysis

The data generated were analysed using GraphPad version 9.7.1 and the results obtained were expressed as the mean concentration of heavy metals.

RESULT

The mean concentration (mg/kg) of cadmium(cd), cobalt(CO), lead (Pb), chromium(Cr) and arsenic(As) in fruits and vegetables (watermelon, cucumber, pawpaw, banana, tomato, carrots, cabbage, Ugwu(fluted pumpkin) and spinach from the Gwagwalada and Zuba market are depicted in Tables 1 and 2 respectively. The corresponding WHO/FAO permissible limits are also indicated

Table 2: Average Concentration of Heavy Metals in Fruits and Vegetables in Zuba

Fruits and Vegetables	Cd(mg/kg)	Co(mg/kg)	Pb(mg/kg)	Cr(mg/kg)	As (mg/kg)
Beetroot	3	3.51	9.1	0	3.96
Watermelon	2.15	5.21	14.64	2.33	4
Cucumber	1.83	2.84	20.4	1.18	0
Pawpaw	2.3	4.1	11.16	0	3.75
Banana	2.3	3	11.76	0	2.69
Tomato	1.82	1.54	4.17	0	2.82
Carrot	2.13	3.26	25.93	0	0
Cabbage	2.33	2.06	3.4	0	4
Ugwu	2.35	5.13	0	0	1
Spinach	2.53	1.3	2.45	0	0
FAO/WHO	0.1	0.05	0.3	2.3	0.3

DISCUSSION

The results of this study revealed widespread contamination of fruits and vegetables sold in Gwagwalada and Zuba markets of Abuja with heavy metals—particularly Cd, Pb, Co, and As—at concentrations significantly exceeding WHO/FAO permissible limits. This reflects broader findings from across Nigeria, suggesting a national trend in food-chain contamination (Tables 1 and 2). The higher than permissible levels of lead in the present study agrees with the findings of Adebayo *et al.* (2025) who reported levels of lead above the WHO permissible levels in vegetables harvested around Sauka area of Abuja FCT and is also consistent with those of Kadijat(2022) who reported higher than permissible levels of cadmium and chromium concentrations in vegetables

Cadmium levels (1.72–3.0 mg/kg) align with findings in vegetables from Lagos and Imo State, where similarly high levels were linked to fertilizer use and waste-contaminated soils (Nwoko and Mgbearuruike, 2011; Oyedele *et al.*, 2008). Pb levels were especially concerning, reaching up to 25.93 mg/kg in carrots, consistent with values reported in Uyo and Ibadan where vegetables grown near roads or on waste dumps exhibited high Pb levels (Uwah *et al.*, 2013; Osu and Onuoha, 2017).

Arsenic concentrations up to 10.5 mg/kg in banana in Gwagwalada market (Table 1) were also comparable to findings from dumpsite-grown vegetables in Uyo (Uwah *et al.*, 2013). Co levels exceeded the safe limit in all samples, higher than those reported in Ogun State (Akinola *et al.*, 2008), suggesting rising environmental inputs. Cr was less frequently detected but found in watermelon and cucumber from Zuba at near-permissible levels, similar to observations by Adepoju-Bello *et al.* (2009) in Lagos.

The consistency of these findings with previous studies suggests a commonality of sources including traffic

emissions, sewage sludge, wastewater irrigation, and industrial runoff. The implications are far-reaching, especially considering the widespread consumption of these crops. Long-term exposure to these metals has been linked to renal damage, neurological disorders, cancer, and reproductive toxicity.

Conclusion

This study revealed that fruits and vegetables sold in Gwagwalada and Zuba markets in Abuja, Nigeria, are contaminated with heavy metals—particularly cadmium, lead, cobalt, and arsenic—at levels significantly exceeding WHO/FAO recommended limits. The consumption of these products may pose serious health risks. Regular monitoring, stricter regulation, and the promotion of safer agricultural practices are essential to safeguarding public health.

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